



Missouri Department of Natural Resources

Biological Assessment Study Report

Logan Creek Reynolds County

September 2011 – March 2012

Prepared for:

Missouri Department of Natural Resources
Division of Environmental Quality
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Water Pollution Control Branch

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Table of Contents

Section	Page
1.0 Introduction.....	1
1.1 Purpose.....	1
1.2 Objectives	1
1.3 Tasks	1
1.4 Null Hypotheses.....	1
2.0 Study Area	2
2.1 Water Quality Concerns.....	2
2.2 Site Descriptions	3
3.0 Methods.....	3
3.1 Habitat.....	3
3.1.1 Land Use	4
3.1.2 Habitat Assessment.....	4
3.2 Physicochemical Data Collection and Analysis	4
3.3 Macroinvertebrate Collection and Analysis.....	4
4.0 Quality Assurance/Quality Control (QA/QC)	5
5.0 Data Results and Analyses.....	5
5.1 Land Use	5
5.2 Habitat Assessment.....	5
5.3 Physicochemical Data	6
5.4 Biological Assessment.....	7
5.4.1 Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure (SMSBPP)	7
5.4.2 Comparisons with Regional Reference Streams in the Ozark/Black/Current EDU.....	8
5.4.3 Logan Creek Longitudinal Comparisons	9
5.4.4 Logan Creek Seasonal Comparisons	9
5.4.5 Macroinvertebrate Percent and Community Composition	9
6.0 Discussion	11
7.0 Conclusions.....	11
8.0 Summary	11
9.0 Literature Cited	12

Tables

	Page
Table 1	Percent Land Cover..... 2
Table 2	Logan Creek Physical Characteristics 3
Table 3	Habitat Scores Fall 2011 5
Table 4	<i>In Situ</i> Water Quality Measurements and Turbidity at Both Stations Fall 2011 6
Table 5	<i>In Situ</i> Water Quality Measurements and Turbidity at Both Stations Spring 2012 6
Table 6	Nutrient, Chloride, and NFR at Logan Creek Fall 2011 6
Table 7	Nutrient, Chloride, and NFR at Logan Creek Spring 2012 7
Table 8	Dissolved Metals Concentrations and Hardness as CaCO ₃ for Logan Creek Fall 2011 7
Table 9	Dissolved Metals Concentrations and Hardness as CaCO ₃ for Logan Creek Spring 2012 7
Table 10	Biological Criteria for Warm Water Reference Streams in the Ozark/Black/Current EDU (Fall Season)..... 8
Table 11	Biological Criteria for Warm Water Reference Streams in the Ozark/Black/Current EDU (Spring Season) 8
Table 12	Metric Values and Stream Condition Indices for Logan Creek, Fall 2010 Sampling Season..... 8
Table 13	Metric Values and Stream Condition Indices for Logan Creek, Spring 2011 Sampling Season..... 8
Table 14	Macroinvertebrate Composition 10
Table 15	Comparison of Percent Heptageniidae Between Logan Creek and BIOREF Streams 10

Attachments

Appendix A	Logan Creek Study Area Map
Appendix B	Macroinvertebrate Bench Sheets

1.0 Introduction

At the request of the Missouri Department of Natural Resources' (**MDNR**) Water Protection Program (**WPP**), MDNR's Environmental Services Program's (**ESP**) Water Quality Monitoring Section (**WQMS**) conducted a biological assessment of Logan Creek. Logan Creek flows through a rural watershed in Reynolds County in southeastern Missouri.

Logan Creek is on the proposed 2012 303(d) list of impaired waters. Its proposed listing is for lead as the pollutant along a 6.1-mile length of the stream. The source of the pollutant is listed as the Sweetwater Lead Mine/Mill.

A similar and simultaneous biological assessment study was in progress for Sweetwater Creek, a tributary of upper Logan Creek. The report for that study should be finalized at approximately the same time of the finalization of this report.

1.1 Purpose

The purpose of this study was to determine if the Logan Creek macroinvertebrate community is impaired and, if so, determine the possible causes.

1.2 Objectives

- Determine if the macroinvertebrate community of Logan Creek is impaired.
- Determine the habitat characteristics of Logan Creek.
- Define the water quality characteristics of Logan Creek.

1.3 Tasks

- Conduct a biological assessment of the macroinvertebrate community of Logan Creek.
- Conduct a habitat assessment of Logan Creek.
- Conduct a water quality assessment of Logan Creek.

1.4 Null Hypotheses

- Macroinvertebrate assemblages are similar between Logan Creek and Biological Criteria Reference (**BIOREF**) streams.
- Macroinvertebrate assemblages are similar between Logan Creek stream segments.
- Macroinvertebrate assemblages are similar between the two sample seasons.

2.0 Study Area

Logan Creek originates south of the town of Reynolds, Missouri. It flows south and turns east through its rural, predominantly forest watershed (Table 1) until its confluence with Clearwater Lake.

According to Chapter 7 of the State Water Quality Standards, 10 CSR 20-7.031 (MDNR 2012a) a 36.0-mile segment of Logan Creek is designated class “P”. That segment begins at sec. 26, T. 31 N., R. 2 W. and ends at the confluence with Clearwater Lake at sec. 27, T. 29 N., R. 2 E. Beneficial use designations are for livestock and wildlife watering, protection of warm water aquatic life, human health—fish consumption, whole body contact recreation A, and secondary contact recreation.

Logan Creek is located within the Ozark/Black/Current Ecological Drainage Unit (**EDU**). An EDU is a region where biological communities and habitat conditions are expected to be similar. See Appendix A for a map of EDUs and the sampling reaches for Logan Creek. See Table 1 for a comparison of land use for the EDU and the 12-digit hydrologic units (**HU**) for Logan Creek.

Table 1
Percent Land Cover

	12-digit HUC	Urban	Cropland	Grassland	Forest	Wetland	Open Water
Ozark/Black/Current EDU		1	0	23	72	1	0
Logan Cr. #1	110100070403	0.5	0.5	14.2	84.7	0.1	0.1
Logan Cr. #2	110100070401	0.7	0.4	11.2	86.4	0.2	1.1

2.1 Water Quality Concerns

The Logan Creek watershed is within the Viburnum Trend that historically has been mined for lead and other metals. The Doe Run Company currently holds a National Pollutant Discharge Elimination System (**NPDES**) permit to discharge into the upper Logan Creek watershed. The permit is for three outfalls: two in the Adair Creek watershed (an unclassified tributary to the very upper end of Logan Creek) and one in the Sweetwater Creek watershed. According to the permit, the only two active outfalls are in the Adair Creek watershed. These outfalls are permitted for the discharge of domestic wastewater at the smaller outfall (design flow of 2,600 gallons per day) and mine operation discharge from the larger outfall with an average flow of 5.2 million gallons per day (**MGD**).

Sediment monitoring for metals conducted by WQMS staff and the United States Geological Survey (**USGS**) on Logan Creek determined that lead levels exceeded guidelines for freshwater ecosystems. Neither the United States Environmental Protection Agency (**USEPA**) nor MDNR have established criteria for pollutants in freshwater sediments. However an extensive literature review conducted by MacDonald

et al. (2000) proposed numeric guidelines for toxic effects. The toxic effects termed “Probable Effect Levels” (**PELs**), are levels at which toxic effects can be expected to frequently occur.

2.2 Site Descriptions

Two Logan Creek sampling locations were selected for this study. Logan Creek sample stations were located in Reynolds County (see map Appendix A). Discharge measurements in cubic feet per second (**cfs**) during both survey periods are given for each sampling station in Table 2.

The sample stations are typical of the Ozark/Black/Current EDU with clear water, adequate riffles, and coarse bottom substrate. As mentioned in Section 2.0, both Logan Creek sample stations are within the class “P” segment of the stream.

Logan Creek Station #1 (sec. 2, T. 30 N., R.2 W.) is located just downstream of the confluence of Sweetwater Creek in Reynolds County. Geographic coordinates at the upstream terminus of this station are UTM Grid 15, East 666125, and North 4131729.

Logan Creek Station #2 (N sec. 35/36, T. 31 N., R. 2 W.) is located just upstream of the Highway B crossing south of Reynolds in Reynolds County. Geographic coordinates at the downstream terminus of this station are UTM Grid 15, East 666564, and North 4134371.

Table 2
Logan Creek Physical Characteristics

Station #	Avg. Width (ft.)	Fall 2011 Discharge (cfs)	Spring 2012 Discharge (cfs)
1	56	10.3	58.3
2	42	11.8	44.9

3.0 Methods

Sampling at Logan Creek was conducted in the fall on September 28, 2011, and in the spring on March 21, 2012. Sampling was conducted by Brian Nodine and Ken Lister of ESP. Sampling consisted of macroinvertebrate collection and water quality sampling. Habitat assessments on Logan Creek as well as a control station within the same EDU were conducted during the fall 2011 sampling season.

3.1 Habitat

Causes of habitat impairment in Ozark streams can include mining and poor forestry practices. As this study was focused primarily on the potential biological effects of metals pollution, and land use in the immediate area did not appear problematic, habitat assessment was primarily focused on the reach scale.

3.1.1 Land Use

Land cover data were derived from the Thematic Mapper satellite data from 2001-2004 and interpreted by the Missouri Resource Assessment Partnership (**MoRAP**). See Section 2.0 and Table 2 for land use information.

3.1.2 Habitat Assessment

A standardized habitat procedure for Riffle/Pool stream types was followed in the Stream Habitat Assessment Project Procedure (**SHAPP**) (MDNR 2012b).

3.2 Physicochemical Data Collection and Analysis

During each survey period, *in situ* water quality measurements were collected at all stations for temperature (°C), dissolved oxygen concentration (mg/L), specific conductance (µS/cm), and pH. These measurements followed Standard Operating Procedures (**SOP**) MDNR-ESP-101 Field Measurement of Water Temperature (MDNR 2010a), MDNR-ESP-103 Sample Collection and Field Analysis for Dissolved Oxygen Using a YSI Membrane Electrode Meter, Hach HQ40d, LDO Probe or YSO ODO Probe (MDNR 2012c), MDNR-ESP-102 Field Analysis for Specific Conductance (MDNR 2010b), and MDNR-ESP-100 Field Analysis of Water Samples for pH (MDNR 2012d), respectively. Additionally, Logan Creek water samples were analyzed by ESP's Chemical Analysis Section (**CAS**) for chloride, total phosphorus, ammonia-N, nitrate + nitrite-N, total nitrogen, dissolved metals, non-filterable residues (**NFR**), and hardness as CaCO₃. Turbidity (**NTU**) was analyzed by the WQMS.

Stream discharge in cfs was measured at each sampling station using a Marsh-McBirney Flo-Mate Model 2000. Discharge was calculated per the methods in the SOP MDNR-ESP-113 Flow Measurement in Open Channels (MDNR 2010c).

Physicochemical data were summarized and presented in tabular form for comparison among the two Logan Creek stations.

3.3 Macroinvertebrate Collection and Analysis

A standardized sample collection procedure was followed as described in the Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure (**SMSBPP**) (MDNR 2010d). Three standard habitats, coarse substrate (**CS**), non-flowing water with depositional substrate (**NF**), and rootmat (**RM**) at the stream edge, were sampled at all locations.

A standardized sample analysis procedure was followed as described in the SMSBPP. The SMSBPP provides details on the calculation of metrics and scoring of the multi-metric Macroinvertebrate Stream Condition Index (**MSCI**). The following four metrics

were used: 1) Taxa Richness (**TR**); 2) total number of taxa in the orders Ephemeroptera, Plecoptera, and Trichoptera (**EPTT**); 3) Biotic Index (**BI**); and 4) Shannon Diversity Index (**SDI**).

Macroinvertebrate data were analyzed in three specific ways. First, Logan Creek stations were compared to biological criteria for the Ozark/Black/Current EDU. Second, a longitudinal comparison between the two Logan Creek sites was performed. Finally, a comparison was made of Logan Creek data between fall and spring sampling seasons. See Tables 10 and 11 for biological criteria for warm water reference streams in the Ozark/Black/Current EDU for the fall and spring.

4.0 Quality Assurance/Quality Control (QA/QC)

QA/QC procedures were followed as described in pertinent Standard Operating and Project Procedures.

5.0 Data Results and Analyses

5.1 Land Use

According to MoRAP land cover files (see Table 1), the watershed land use of Logan Creek is mostly forest, followed by grassland, and minimal other uses.

5.2 Habitat Assessment

Habitat assessment scores were recorded for each sampling station. Results are presented in Table 3. According to the project procedure guidance, the total score from the physical habitat assessment of the study sites should be at least 75% of the total score of the habitat assessment(s) of a control station(s) to support a similar biological community. Habitat scores for the two Logan Creek stations were compared with those of a control stream within the same EDU. In this study the BIOREF, Blair Creek in Shannon County, was used as a habitat control. Both Logan Creek stations met the 75% threshold. It is therefore inferred that based on habitat scores, the two Logan Creek stations should support biological communities comparable to BIOREFs in the EDU.

Table 3
Habitat Scores Fall 2011

Control Stream	Score	Logan Creek	Score	% of Control Score
Blair Creek	138	Station #1	157	114
		Station #2	153	111

5.3 Physicochemical Data

In situ water quality measurements and turbidity are summarized in Table 4 (fall 2011) and Table 5 (spring 2012). Mean temperatures at Logan Creek stations were 15.5°C in fall 2011 and 13.5°C in the spring 2012 survey.

Logan Creek specific conductance levels were somewhat higher during the fall sampling season. Dissolved oxygen levels were consistent between stations within seasons and did not fall below the Water Quality Standards minimum concentration for warm-water and cool-water fisheries (5.0 mg/L). Typically, dissolved oxygen levels are higher during the spring season when water temperatures are cooler. Turbidity levels were consistent within sampling seasons and were particularly low during the fall season.

Table 4
In situ Water Quality Measurements and Turbidity at Logan Creek Stations for Fall 2011

Station	Parameter				
	Temp. (°C)	Diss. O ₂ (mg/L)	Spec. Cond. (µS/cm)	pH	Turb. (NTU)
1	16.0	7.38	462	7.8	0.39
2	15.0	7.93	523	8.1	0.39

Table 5
In situ Water Quality Measurements and Turbidity at Logan Creek Stations for Spring 2012

Station	Parameter				
	Temp. (°C)	Diss. O ₂ (mg/L)	Spec. Cond. (µS/cm)	pH	Turb. (NTU)
1	14.0	9.35	205	7.6	3.12
2	13.0	9.24	383	7.6	2.42

Nutrient, chloride, and NFR concentrations for Logan Creek stations are presented in Table 6 (fall 2011) and Table 7 (spring 2012). All chloride levels were below chronic criteria for protection of aquatic life.

Table 6
 Nutrient, Chloride, and NFR Concentrations at Logan Creek Stations for Fall 2011

Logan Cr. Station	Sample #	Parameter (mg/L)					
		NH ₃ -N	NO ₃ + NO ₂ -N	Total N	Total P	Chloride	NFR
1	1107090	<0.03	0.24	0.26	<0.01	27.7	<5
2	1107089	<0.03	0.34	0.37	<0.01	31.8	<5

Table 7
 Nutrient, Chloride, and NFR Concentrations at Logan Creek Stations for Spring 2012

Logan Cr. Station	Sample #	Parameter (mg/L)					
		NH ₃ -N	NO ₃ + NO ₂ -N	Total N	Total P	Chloride	NFR
1	1202908	<0.03	0.12	0.17	<0.01	4.18	<5
2	1202907	0.056	0.64	0.76	<0.01	25.3	<5

Total dissolved metals concentrations and hardness as CaCO₃ for Logan Creek stations are presented in Table 8 (fall 2011) and Table 9 (spring 2012). All dissolved metals were within Water Quality Standards criteria with an exception. Both Logan Creek stations during the spring 2012 sample season had lead (**Pb**) results that exceeded the hardness dependent chronic criteria for the protection of aquatic life. At Station #1, with a hardness of 46.0 mg/L, dissolved lead exceeded the chronic criteria concentration of 1 µg/L. With a hardness of 135 mg/L, dissolved lead at Station #2 exceeded the 3 µg/L chronic criteria.

Table 8
 Dissolved Metals Concentrations and Hardness as CaCO₃ at Logan Creek Stations for Fall 2011

Station	Parameter (*all parameters measured as µg/L except Ca, Mg, and hardness as mg/L)											
	Ba	Cd	Co	Cu	Pb	Mn	Ni	Zn	Ca*	Fe	Mg*	Hardness*
1	52.4	<0.1	<1	1.08	<0.5	2.13	0.77	9.26	35.3	2.24	23.5	185
2	48.5	0.27	<1	1.35	1.16	17.5	2.6	26.4	39.8	4.15	26.2	207

Table 9
 Dissolved Metals Concentrations and Hardness as CaCO₃ at Logan Creek Stations for Spring 2012

Station	Parameter (*all parameters measured as µg/L except Ca, Mg, and hardness as mg/L)											
	Ba	Cd	Co	Cu	Pb	Mn	Ni	Zn	Ca*	Fe	Mg*	Hardness*
1	22.8	0.15	<1	1.20	3.37**	4.17	1.25	19.9	9.14	53.9	5.63	46.0
2	30.7	0.26	1.35	1.50	4.34**	35.4	9.35	57.6	26.2	21.6	16.8	135

**exceeds chronic criteria for protection of aquatic life at hardness

5.4 Biological Assessment

5.4.1 Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure (SMSBPP)

The SMSBPP evaluation used biological criteria that were calculated for the Ozark/Black/Current EDU from ESP's Wadeable/Perennial Biological Reference Stream database. See Biological Criteria for Wadeable/Perennial Streams of Missouri (MDNR 2002) for more explanation. These criteria are listed for fall and spring seasons in Tables 10 and 11, respectively. Macroinvertebrate Stream Condition Index scores of 20-16 qualify as fully supporting, 14-10 as partially supporting, and 8-4 as non-supporting of

the protection of warm water aquatic life beneficial use designation as listed in the Missouri Water Quality Standards (MDNR 2012a).

Table 10
 Biological Criteria for Warm Water Reference Streams in the Ozark/Black/Current EDU
 (Fall Season)

Metric	Score = 5	Score = 3	Score = 1
TR	>85	85-43	<43
EPTT	>25	25-13	<13
BI	<5.2	5.2-7.6	>7.6
SDI	>3.28	3.28-1.64	>1.64

Table 11
 Biological Criteria for Warm Water Reference Streams in the Ozark/Black/Current EDU
 (Spring Season)

Metric	Score = 5	Score = 3	Score = 1
TR	>93	93-47	<47
EPTT	>31	31-15	<15
BI	<5.4	5.4-7.7	>7.7
SDI	>3.36	3.36-1.68	>1.68

5.4.2 Comparisons with Regional Reference Streams in the Ozark/Black/Current EDU

Macroinvertebrate Stream Condition Indices were calculated for Logan Creek as derived from biological criteria from Ozark/Black/Current EDU reference streams. The four metrics, total scores, and MSCI scores during fall 2011 and spring 2012 are presented in Tables 12 and 13, respectively.

Table 12
 Metric Values and Stream Condition Indices, Fall 2011 Sampling Season

Station	Sample #	TR	EPTT	BI	SDI	MSCI	Support
Logan Cr. #1	110954	83	26	6.3	3.46	16	Fully
Logan Cr. #2	110953	81	19	5.6	3.42	14	Partially

Table 13
 Metric Values and Stream Condition Indices, Spring 2012 Sampling Season

Station	Sample #	TR	EPTT	BI	SDI	MSCI	Support
Logan Cr. #1	120004	93	25	5.5	3.61	14	Partially
Logan Cr. #2	120003	87	20	5.8	3.12	12	Partially

5.4.3 Logan Creek Longitudinal Comparisons

Both Logan Creek stations received a “partially supporting” ranking during both seasons with the exception of the fall Station #1 sample. During each season, both stations received MSCI scores that were only one score level different from the other; therefore, actual MSCI scores did not differ substantially.

5.4.4 Logan Creek Seasonal Comparisons

Each sampling station only differed by one MSCI score level between seasons. Between seasons, each station was one MSCI score lower during the spring 2012 season than the fall 2011 season. Therefore, there was no notable difference between seasons within sample stations.

5.4.5 Macroinvertebrate Percent and Community Composition

Percent relative abundance of EPT and Diptera as well as top five dominant families are presented in Table 14 for both sampling seasons. The percent of relative abundance data were averaged from the sum of the three macroinvertebrate habitats (coarse substrate, depositional non-flow, and rootmat) sampled at each station.

Ephemeroptera was the dominant order at both Logan Creek stations during both seasons, with the exception of Station #1 where Diptera and Ephemeroptera were equally abundant during the spring 2012 sample season. Chironomidae was the dominant family at both stations during both sample seasons.

Percent Heptageniidae for Logan Creek as well as its BIOREF streams is represented in Table 15. The family Heptageniidae is particularly sensitive to metals contamination (Clements et al. 2000). With the exceptions of Little Black River and Sinking Creek in Reynolds County, Heptageniidae percentages are noticeably higher in BIOREF streams than Logan Creek. Station #2, which is closer to the active outfalls, has the lowest percentage of Heptageniidae between the two Logan Creek stations. In both seasons Heptageniidae failed to make up as much as one percent of the Station #2 sample.

At Station #2 only one taxon of Heptageniidae, unidentifiable Heptageniidae, occurred during the fall 2011 season and two taxa, unidentifiable Heptageniidae and a single *Stenonema femoratum*, occurred during the spring season. At Station #1 two other taxa of Heptageniidae occurred during both sample seasons, *Maccaffertium pulchellum* and *Maccaffertium mediopunctatum*.

Table 14
 Macroinvertebrate Composition

Logan Creek	Fall 2011		Spring 2012	
	Station #1	Station #2	Station #1	Station #2
% Ephemeroptera	37.5	31.2	32.2	39.8
% Plecoptera	0.2	0.4	10.6	8.5
% Trichoptera	8.2	16.3	11.0	7.8
Total EPT %	45.9	47.9	54.2	56.1
% Diptera	33.9	28.9	32.2	32.9
% Top Five Dominant Families				
Chironomidae	30.0	26.8	25.9	27.5
Caenidae	25.8	17.4	20.9	33.4
Elmidae	8.9			
Hydropsychidae	5.0	7.8	5.5	
Baetidae	3.9			
Isonychidae		12.0		4.8
Leptoceridae		7.5		
Leuctridae			6.0	4.9
Heptageniidae			5.0	
Gomphidae				3.2

Table 15
 Comparison of Percent Heptageniidae between Logan Creek and BIOREF Streams

BIOREF			Logan Creek		
Stream	Fall 2011	Spring 2012	Station	Fall 2011	Spring 2012
Blair Creek	13.8	12.0	1	3.5	5.0
Big Creek	12.5	8.4	2	0.3	0.9
Sinking Creek (Shannon Co.)	8.7	8.9			
Sinking Cr. (Reynolds Co.)	4.5	3.2			
L. Black R. (A)	5.9	2.3			
L. Black R. (B)	4.5	-			
Jacks Fork	18.8	11.4			
Mean %	9.8	7.7		3.6	3.0

6.0 Discussion

This study shows Logan Creek to be only partially supporting of the protection of warm water aquatic life beneficial use designation at both stations sampled. The only exception was Station #1 during the fall sampling season, which scored at the lowest end of “fully supporting”. One less EPT taxon, however, would have put the Station #1 fall sample in the “partially supporting” category.

Among the physicochemical results that could help explain the failure of Logan Creek to attain all “fully supporting” MSCI scores, especially during the spring 2012 sample season, are the dissolved lead concentrations. The dissolved lead in the surface water that exceeded chronic criteria for protection of aquatic life complements the lead contaminated sediment that prompted the proposed listing of Logan Creek.

The notably low percentage of Heptageniidae in Logan Creek, especially at Station #2 closer to the permitted outfalls, is another indicator of potential impairment by heavy metal contamination.

Sensitive taxa such as mayflies, particularly a species within the genus *Rhithrogena* in the family Heptageniidae, have been shown to exhibit recovery with the reduction of contaminated drainage from metals mining operations in as little as two years (Nelson and Roline 1996). This ability to recover once metals mining drainage has ceased is further evidence of the effects of heavy metals contamination on macroinvertebrate community structures.

Besides a noted marginal degree of heterogeneity in substrate size in the coarse substrate at Station #2, habitat does not appear to be the cause of any impairment in the macroinvertebrate communities in the Logan Creek study area.

7.0 Conclusions

Based on this study, there may be a conclusion drawn that Logan Creek is not biologically sustainable to benthic macroinvertebrates. The lack of fully supporting MSCI scores is most likely the result of metals impairment, particularly lead, from mine discharge.

8.0 Summary

- The null hypothesis that macroinvertebrate assemblages are similar between Logan Creek and BIOREF streams in the same EDU is not accepted.
- The null hypothesis that macroinvertebrate assemblages are similar between Logan Creek stream segments is accepted.
- The null hypothesis that macroinvertebrate assemblages will not differ between the two sample seasons is accepted.

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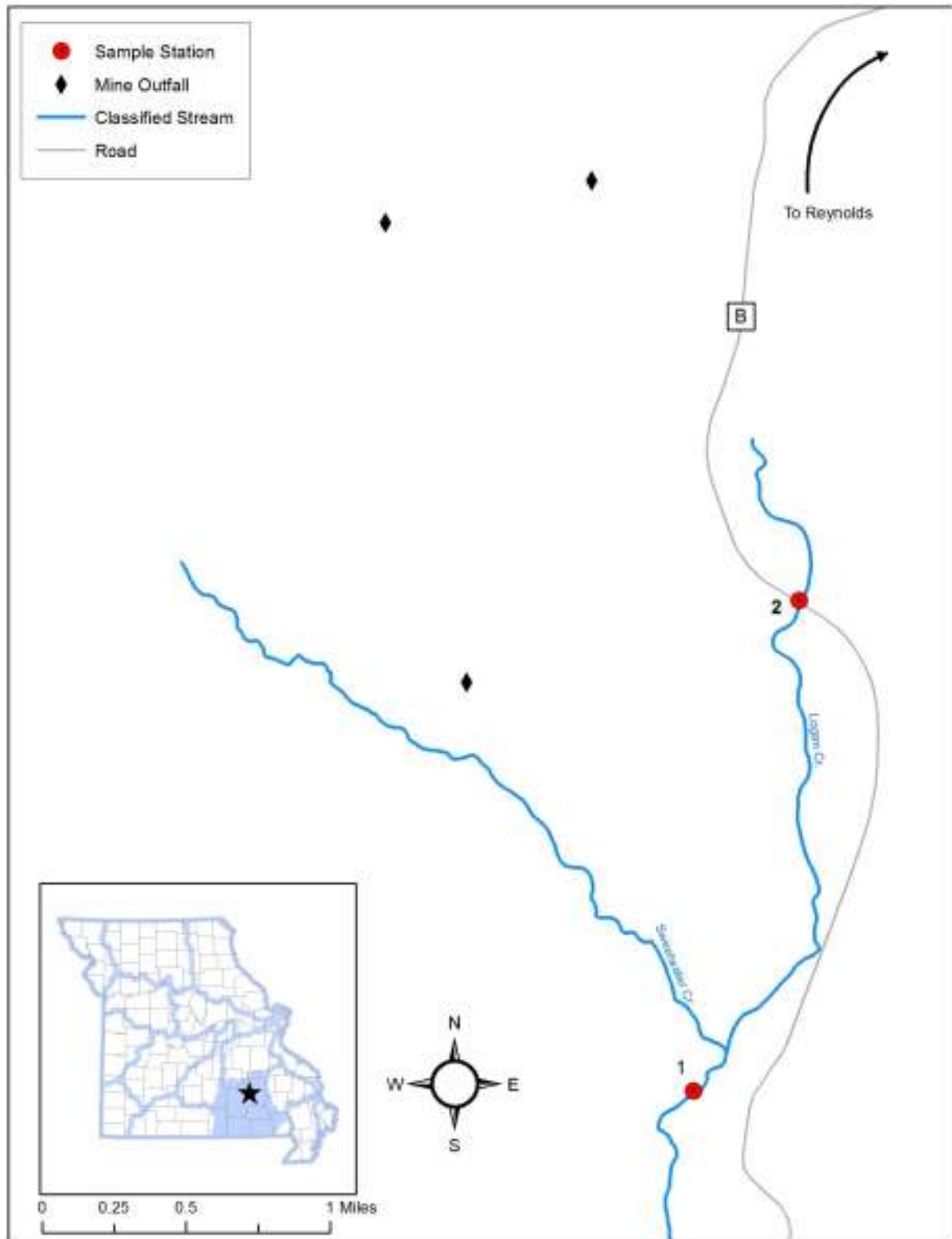
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Appendix A
Logan Creek Study Area Map

Logan Creek FY 2012 Bioassessment Study Area



Appendix B

Macroinvertebrate Bench Sheets

Aquid Invertebrate Database Bench Sheet Report			
Logan Cr [110954], Station #1, Sample Date: 9/28/2011 12:12:00 PM			
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence			
ORDER: TAXA	CS	NF	RM
"HYDRACARINA"			
Acarina	13	6	
AMPHIPODA			
Hyaella azteca			6
COLEOPTERA			
Ancyronyx variegatus			4
Berosus		1	4
Dubiraphia		27	10
Ectopria nervosa	-99		2
Optioservus sandersoni	22	1	
Psephenus herricki	5	3	1
Stenelmis	42	1	1
DIPTERA			
Ablabesmyia	1	6	
Cardiocladius	1		
Ceratopogoninae	2		27
Cladotanytarsus	3		
Cricotopus bicinctus	3	1	7
Cricotopus/Orthocladius	22	2	18
Culicidae			1
Dicrotendipes	1	9	5
Djalmabatista		1	
Forcipomyiinae		1	
Hemerodromia		2	
Hexatoma	10		
Nilotanypus	2		
Parakiefferiella	2	8	14
Parametriocnemus	13		
Paratanytarsus		5	57
Pentaneura	1		
Phaenopsectra		3	
Polypedilum	3		
Polypedilum aviceps	6		
Polypedilum convictum	20		1
Polypedilum illinoense grp		1	
Procladius		1	
Psectrocladius		1	4
Pseudochironomus	2		
Rheotanytarsus	19		
Simulium	4		
Stempellinella	11	2	

Aquid Invertebrate Database Bench Sheet Report			
Logan Cr [110954], Station #1, Sample Date: 9/28/2011 12:12:00 PM			
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence			
ORDER: TAXA	CS	NF	RM
Tabanus	-99		
Tanytarsus	50	9	11
Thienemanniella		1	2
Thienemannimyia grp.	34		2
EPHEMEROPTERA			
Acentrella	4		
Baetis	33		1
Caenis anceps	80	17	1
Caenis latipennis	58	136	22
Centroptilum	1	3	
Ephemerellidae	2		
Heptageniidae	26		
Isonychia bicolor	30		
Leptophlebiidae	1		
Maccaffertium mediopunctatum	2		
Maccaffertium pulchellum	10		
Procloeon		4	2
Stenonema femoratum		5	
Tricorythodes	16	1	1
LEPIDOPTERA			
Petrophila			1
LIMNOPHILA			
Ancylidae		7	
Helisoma			-99
Menetus		2	6
Physella			3
LUMBRICULIDA			
Lumbriculidae	1		
MEGALOPTERA			
Corydalus	-99		
Sialis			-99
ODONATA			
Argia	2	8	6
Basiaeschna janata			-99
Enallagma		1	22
Gomphidae	16	1	
Hagenius brevistylus		1	
Macromia		1	-99
Stylogomphus albistylus		2	
PLECOPTERA			
Acroneuria	-99		

Aquid Invertebrate Database Bench Sheet Report			
Logan Cr [110954], Station #1, Sample Date: 9/28/2011 12:12:00 PM			
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence			
ORDER: TAXA	CS	NF	RM
Amphinemura		1	
Leuctridae		1	
Neoperla	1		
TRICHOPTERA			
Cheumatopsyche	61		
Helicopsyche	18	1	1
Mystacides		1	
Oecetis	1		2
Oxyethira			3
Phryganeidae		1	
Polycentropus	1		
Triaenodes		1	9
TRICLADIDA			
Planariidae	11	1	1

Aquid Invertebrate Database Bench Sheet Report			
Logan Cr [110953], Station #2, Sample Date: 9/28/2011 9:20:00 AM			
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence			
ORDER: TAXA	CS	NF	RM
"HYDRACARINA"			
Acarina	12	5	8
AMPHIPODA			
Hyaella azteca			2
Stygobromus		1	
COLEOPTERA			
Berosus		3	
Dubiraphia		14	10
Ectopria nervosa		2	3
Macronychus glabratus			12
Optioservus sandersoni	39	1	
Psephenus herricki	6	3	
Stenelmis	14		1
DECAPODA			
Orconectes hylas	-99		
DIPTERA			
Ablabesmyia	1	11	2
Antocha	1		
Atherix	1		
Cardiocladius	4		
Ceratopogoninae			3
Chironomidae		1	4
Cladotanytarsus		1	1
Corynoneura		1	
Cricotopus bicinctus	31	1	10
Cricotopus/Orthocladius	43	2	6
Dasyheleinae		1	1
Dicrotendipes			1
Dixella			1
Djalmabatista		2	4
Hemerodromia	9		3
Labrundinia		1	19
Microtendipes			1
Nanocladius		2	
Nilotanypus	4		
Pagastiella		2	
Parachironomus			1
Parakiefferiella		42	4
Parametriocnemus	10	1	
Paratanytarsus			3

Aquid Invertebrate Database Bench Sheet Report			
Logan Cr [110953], Station #2, Sample Date: 9/28/2011 9:20:00 AM			
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence			
ORDER: TAXA	CS	NF	RM
Paratendipes		1	
Polypedilum aviceps	1		
Procladius		6	
Pseudochironomus		8	1
Rheotanytarsus	29	1	1
Simulium	6		
Stempellinella	3	4	2
Stenochironomus			2
Stictochironomus		2	
Tabanus	-99		
Tanytarsus	8	1	10
Thienemanniella	13		
Thienemannimyia grp.	12		15
Tipula	1		
EPHEMEROPTERA			
Acentrella	7		
Baetis	7		
Caenis anceps	10		
Caenis latipennis	68	127	13
Heptageniidae	4		
Isonychia bicolor	151		
Tricorythodes	4		
LEPIDOPTERA			
Petrophila	1		
LIMNOPHILA			
Menetus			6
Physella			4
MEGALOPTERA			
Corydalus	10	1	
ODONATA			
Argia	3	7	28
Calopteryx			1
Enallagma		2	11
Gomphidae	44	2	
Hagenius brevistylus	1	17	1
Macromia			6
Stylogomphus albistylus	2		
PLECOPTERA			
Leuctridae	6		
TRICHOPTERA			
Ceratopsyche morosa grp	3		

Aquid Invertebrate Database Bench Sheet Report			
Logan Cr [110953], Station #2, Sample Date: 9/28/2011 9:20:00 AM			
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence			
ORDER: TAXA	CS	NF	RM
Cheumatopsyche	66		
Chimarra	3		
Helicopsyche	1	2	
Hydropsychidae	29		
Leptoceridae			12
Mystacides		1	
Oecetis		1	5
Oxyethira		3	1
Polycentropus	1		1
Triaenodes			76
TRICLADIDA			
Planariidae	1		
TUBIFICIDA			
Tubificidae			3

Aquid Invertebrate Database Bench Sheet Report			
Logan Cr [120004], Station #1, Sample Date: 3/21/2012 11:00:00 AM			
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence			
ORDER: TAXA	CS	NF	RM
"HYDRACARINA"			
Acarina	3		2
COLEOPTERA			
Ancyronyx variegatus		2	1
Berosus		1	1
Dubiraphia	1	14	3
Helichus lithophilus			3
Macronychus glabratus		-99	2
Optioservus sandersoni	3	1	
Paracymus			1
Psephenus herricki	4	2	
Stenelmis	4	6	
DECAPODA			
Orconectes hylas			1
Orconectes virilis			1
DIPTERA			
Ablabesmyia		11	2
Antocha	3		
Ceratopogoninae	3	9	
Chironomidae		2	
Chrysops		1	
Cladotanytarsus		5	
Clinocera	2		
Corynoneura		1	
Cricotopus bicinctus	1		9
Cricotopus/Orthocladius	3	6	24
Dicrotendipes	1	5	1
Diptera		1	
Djalmabatista	1	6	1
Eukiefferiella	1		
Hemerodromia	10	7	2
Hexatoma	4		
Labrundinia			8
Lauterborniella		1	
Microtendipes	1		
Molophilus	1		
Nanocladius			1
Pagastiella		1	
Parakiefferiella		22	1
Parametriocnemus	3	2	

Aquid Invertebrate Database Bench Sheet Report			
Logan Cr [120004], Station #1, Sample Date: 3/21/2012 11:00:00 AM			
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence			
ORDER: TAXA	CS	NF	RM
Paratanytarsus		2	17
Phaenopsectra		1	
Polypedilum aviceps	11	1	
Polypedilum convictum	1		
Procladius		5	
Psectrocladius			4
Rheotanytarsus	4	2	4
Robackia	4		
Simulium	11		
Stempellinella		5	
Stictochironomus		3	1
Tabanus	1		
Tanytarsus	3	17	6
Thienemannimyia grp.	11	7	9
Tipula	3		
Zavrelimyia			1
EPHEMEROPTERA			
Acentrella	17		2
Baetisca lacustris		3	8
Caenis latipennis	27	73	93
Eurylophella bicolor	2		10
Heptageniidae	4	1	
Isonychia bicolor	16		
Maccaffertium mediopunctatum	1		
Maccaffertium pulchellum	32		
Stenonema femoratum	4	3	1
LEPIDOPTERA			
Petrophila	1		
LIMNOPHILA			
Ancylidae		1	
Menetus	1		
MEGALOPTERA			
Corydalus	3		
Nigronia serricornis		-99	
ODONATA			
Argia	3	6	4
Calopteryx		-99	4
Enallagma		-99	10
Gomphidae	1	4	
Hagenius brevistylus	1	14	3
Helocordulia		-99	3

Aquid Invertebrate Database Bench Sheet Report			
Logan Cr [120004], Station #1, Sample Date: 3/21/2012 11:00:00 AM			
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence			
ORDER: TAXA	CS	NF	RM
Libellula			1
Macromia		1	1
PLECOPTERA			
Amphinemura	5		2
Chloroperlidae	9		
Isoperla	18		7
Leuctridae	23	30	3
Pteronarcys pictetii	1		
TRICHOPTERA			
Cheumatopsyche	49	1	1
Chimarra	4		
Helicopsyche	2	1	3
Mystacides		2	
Oecetis		1	1
Oxyethira			24
Polycentropus	5	-99	2
Psychomyia	1		
Ptilostomis		-99	1
Pycnopsyche			2
Trienodes			2
TUBIFICIDA			
Enchytraeidae			1
Limnodrilus hoffmeisteri		1	
Tubificidae		6	

Aquid Invertebrate Database Bench Sheet Report			
Logan Cr [120003], Station #2, Sample Date: 3/21/2012 9:10:00 AM			
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence			
ORDER: TAXA	CS	NF	RM
"HYDRACARINA"			
Acarina	9	19	
AMPHIPODA			
Hyalella azteca			1
COLEOPTERA			
Ancyronyx variegatus		1	1
Berosus	2	4	
Dubiraphia		6	2
Ectopria nervosa	2	1	
Macronychus glabratus			1
Optioservus sandersoni	4		
Stenelmis	6		
DIPTERA			
Ablabesmyia		4	2
Antocha	5		
Cardiocladius	1		
Ceratopogoninae	1	3	4
Chelifera		1	
Chironomidae	2		1
Cladotanytarsus	11	1	
Clinocera	6		
Corynoneura			7
Cricotopus bicinctus	7	2	20
Cricotopus/Orthocladius	54	8	26
Dicrotendipes	1	5	4
Diptera	1	1	
Djalmabatista		3	
Eukiefferiella			1
Gymnometriocnemus	1		
Hemerodromia	15	5	3
Labrundinia		1	3
Micropsectra	1		1
Microtendipes	1		
Nilotanypus	1		
Pagastiella		1	
Parakiefferiella	5	3	1
Parametriocnemus	23		1
Paraphaenocladius			1
Paratanytarsus		1	3
Phaenopsectra		1	

Aquid Invertebrate Database Bench Sheet Report			
Logan Cr [120003], Station #2, Sample Date: 3/21/2012 9:10:00 AM			
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence			
ORDER: TAXA	CS	NF	RM
Polypedilum aviceps	17	1	
Polypedilum convictum	5	1	
Psectrocladius	1		2
Pseudosmittia	1		
Rheocricotopus	7		2
Rheotanytarsus	15	2	15
Simulium	12		1
Stempellinella	3		
Stenochironomus			1
Symptothastia	1	1	
Tabanus	4		
Tanytarsus	6	2	4
Thienemannimyia grp.	9	11	6
Tipula		3	-99
Tribelos	1		
Tvetenia bavarica grp	6		1
Zavrelimyia		1	1
EPHEMEROPTERA			
Acentrella	2	1	
Baetisca lacustris	2		
Caenis latipennis	174	131	98
Centroptilum			1
Eurylophella		1	
Heptageniidae	1		
Isonychia bicolor	55		4
Maccaffertium pulchellum	6		
Stenonema femoratum	1	3	
LEPIDOPTERA			
Petrophila	3		
LUMBRICINA			
Lumbricina	1	1	
MEGALOPTERA			
Corydalus	1		
Nigronia serricornis		1	
ODONATA			
Argia	3	6	4
Calopteryx		1	2
Enallagma	1		1
Gomphidae	10	4	4
Hagenius brevistylus	2	19	
Hetaerina			1

Aquid Invertebrate Database Bench Sheet Report			
Logan Cr [120003], Station #2, Sample Date: 3/21/2012 9:10:00 AM			
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence			
ORDER: TAXA	CS	NF	RM
Libellula		1	
Macromia		1	1
PLECOPTERA			
Amphinemura	33		3
Leuctridae	28	17	15
Perlesta	5		2
TRICHOPTERA			
Cheumatopsyche	22	2	
Chimarra	10		
Hydroptila	2		3
Mystacides		2	
Oecetis		1	4
Oxyethira	3	4	19
Polycentropus	2	2	3
Triaenodes			16
TUBIFICIDA			
Enchytraeidae	2	1	
VENEROIDA			
Pisidiidae	1		